

# EARLY DEVELOPMENTAL STAGES OF THE BROWN SHRIMP, *Penaeus aztecus* IVES, REARED IN THE LABORATORY<sup>1</sup>

HARRY L. COOK<sup>2</sup> AND M. ALICE MURPHY<sup>3</sup>

## ABSTRACT

The larval and first postlarval stages of the brown shrimp, *Penaeus aztecus* Ives, reared from eggs spawned in the laboratory, as well as the eggs themselves, are described and illustrated. The larvae and first postlarva are compared with those of the pink shrimp, *P. duorarum* Burkenroad, and white shrimp, *P. setiferus* (Linn.).

Commercial shrimp landings from Gulf of Mexico and South Atlantic waters of the United States are comprised mainly of three species: the brown shrimp, *Penaeus aztecus* Ives; the pink shrimp, *P. duorarum* Burkenroad; and the white shrimp, *P. setiferus* (Linn.). The Gulf coast shrimp fishery is the most valuable of domestic commercial fisheries, and in 1968 the value to fishermen for shrimp caught in the Gulf amounted to nearly \$95 million. Because of their relative importance, these shrimps are being intensively studied by the National Marine Fisheries Service in an effort to understand more fully their biology and ecology.

Thirteen species of penaeid shrimp representing five genera inhabit the shallow near-shore waters of the northwestern Gulf. At the present time their larvae can only be identified to genus (Cook, 1966). Within genera the larvae are so similar morphologically that at any given stage the various species cannot yet be distinguished. Since adults of the three commercially important species often occur together and overlap in their spawning activity, there is also some intermingling of their planktonic larvae. To answer basic questions about larval distribution, growth, and survival of each spe-

cies, accurate identification of larvae is essential.

The larval and early postlarval stages of the pink shrimp were described by Dobkin (1961), and those of the white shrimp by Pearson (1939) and Heegaard (1953). These shrimp have five naupliar, three protozoal, three mysis, and several postlarval stages. Their morphological characteristics during these stages are so alike, however, that biologists still encounter difficulty in differentiating the two species. Since the early developmental stages of the brown shrimp have not been described, the purpose of this paper is to do so and at the same time compare them with corresponding stages of the pink and white shrimps.

## METHODS AND MATERIALS

Larvae of the brown shrimp were first successfully cultured in the laboratory during the fall of 1963. Since that time, culture techniques have improved greatly. The methods used in our culture of larval penaeid shrimp were described by Cook and Murphy (1966), Cook (1969), and Cook and Murphy (1969).

Specimens of each stage were preserved for descriptive purposes. Drawings were made with the aid of a camera lucida. The figures of each substage are composite and represent an "average" larvae rather than any one individual. Also, with the exception of the nauplii, appendages on these figures are intended to indicate only relative size and position, not to show details of setation. The enlarged figures of

<sup>1</sup> Contribution No. 309, National Marine Fisheries Service Biological Laboratory, Galveston, Texas 77550.

<sup>2</sup> Formerly National Marine Fisheries Service Biological Laboratory, Galveston, Texas; present address: Division of Contract Research, Texas Division, Dow Chemical Company, Freeport, Texas 77541.

<sup>3</sup> National Marine Fisheries Service Biological Laboratory, Galveston, Texas 77550.

mouth parts and other appendages were taken from two individuals representing each substage. Setules on the setae of the larvae were deliberately omitted, and naupliar appendages were rotated on their axes to avoid cluttering the figures and obscuring important diagnostic characters.

Abbreviations used in the text are: TL = total length, including rostrum when present but excluding caudal spines; W = body width at the point of greatest width; CL = carapace length, including the rostrum; and N = the number of specimens examined.

## DESCRIPTION OF DEVELOPMENTAL STAGES

### EGG AND HATCHING

(Fig. 1)

Diameter 0.26 mm

Viable eggs are round, golden brown, and translucent. As the nauplius develops, it fills the egg case and can be seen moving sporadically. At hatching, the egg case splits and the posterior portion of the nauplius protrudes. Then the nauplius, unmoving, appears to swell until it is

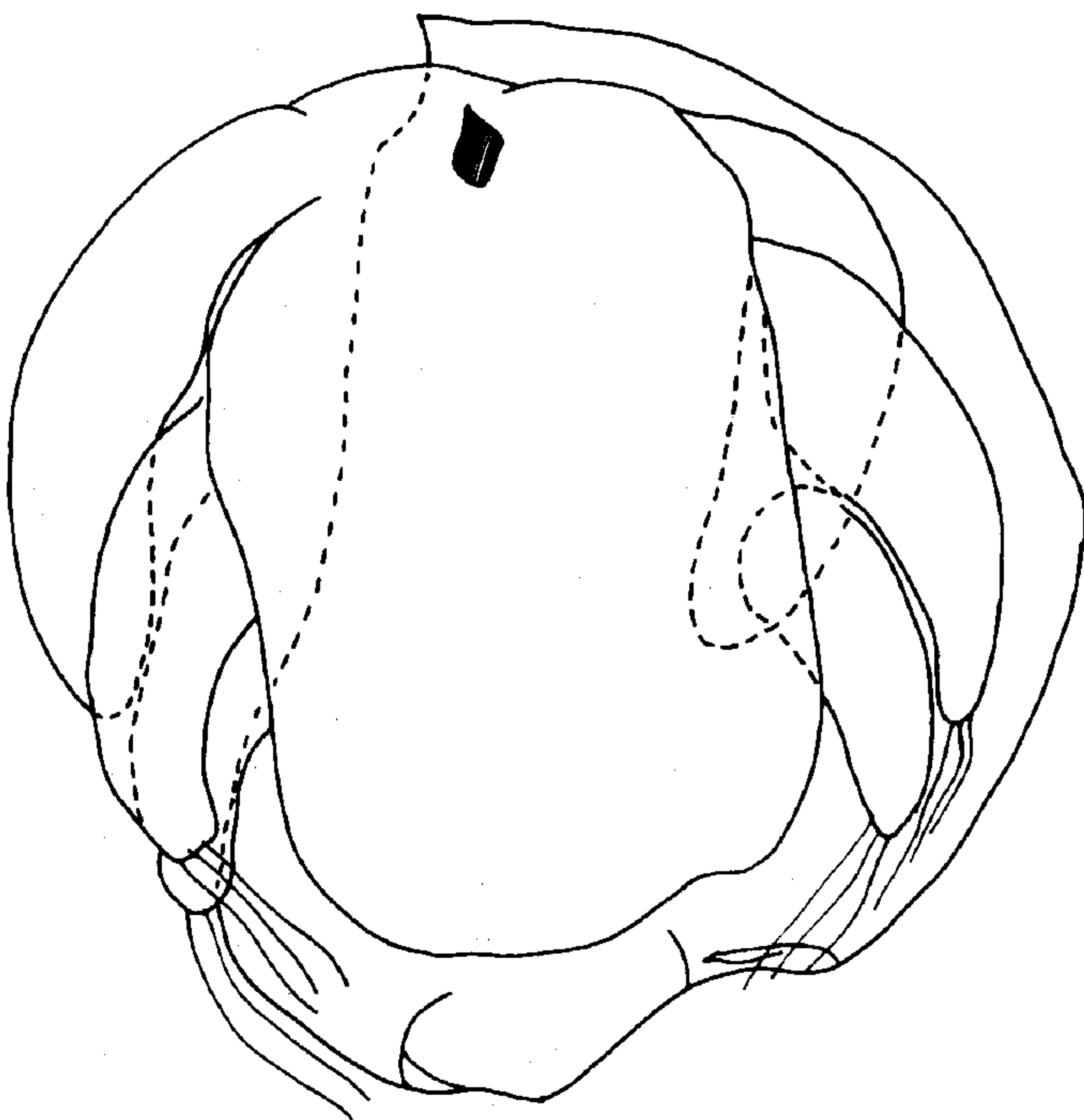


FIGURE 1.—Nauplius emerging from egg.

forced from the shell, the entire process taking about 30 sec.

When first hatched, the nauplius rests almost motionless for 3 to 5 min. Although the appendages do not move during this time, spastic movement can be seen within the body near the base of each appendage. Suddenly the nauplius folds its appendages posteriorly along the ventral margins of the body, and, in one quick movement, sheds from its posterior end a loose-fitting exoskeleton and starts swimming actively. At first, the nauplius alternates 2- to 3-sec periods of swimming with resting periods of equal duration.

### NAUPLIUS I

(Fig. 2)

Mean TL = 0.35 mm (0.32-0.38 mm)

Mean W = 0.19 mm (0.18-0.21 mm)

N = 55

The pyriform body is unsegmented and possesses a ventrally projecting labrum. An ocellus, which persists in subsequent naupliar substages, is present near the anterior end. The dorsal surface of the body is smooth except for a small median spine posteriorly (Fig. 2b). The posterior portion of the body is rounded and bears a single pair of caudal spines.

The body color in all naupliar substages is a

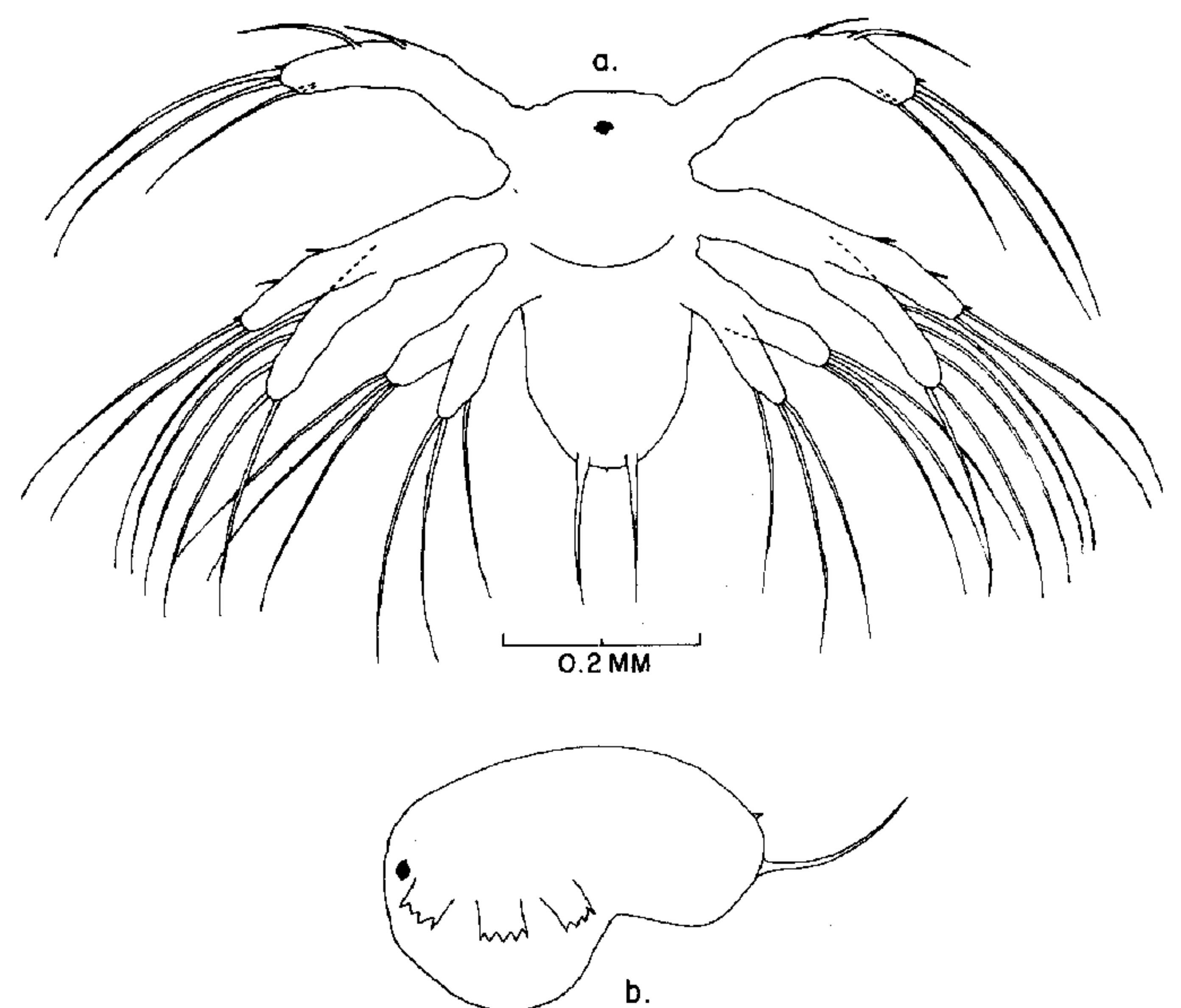


FIGURE 2.—Nauplius I: a, ventral view; b, lateral view.

golden brown, with the appendages tinged red apically. The translucent body appears filled with small granules that flow freely when the cuticle is ruptured.

Three pairs of appendages are present. The first antennae are uniramous and slightly less than three-quarters the length of the body. Each second antenna is biramous, its endopod slightly shorter than the exopod, and approximately three-quarters the body length. The mandibles are biramous and slightly less than one-half the body length.

In this substage all setae are smooth, but in subsequent substages, the longer ones are plumose.

**Setation of appendages:**

First antenna: Two short ventrolateral; two long terminal plus a small spike; one long dorsolateral.

**Second antenna:**

Endopod: Two short ventrolateral; two long terminal plus a small spike.

Exopod: Three long ventrolateral; two long terminal.

Mandible: Both branches bear three long setae.

**NAUPLIUS II**

(Fig. 3)

Mean TL = 0.39 mm (0.36-0.41 mm)

Mean W = 0.20 mm (0.20-0.21 mm)

N = 27

Body shape is similar to that of the first nauplius except that the posterior end is no longer rounded; the portion between the single pair of furcal spines has become straightened. The small dorsomedian spine near the posterior end (present in the first substage) is absent in this substage.

**Setation of appendages:**

First antenna: One short and one medium ventrolateral; one short, one medium, and one long terminal; one medium dorsolateral.

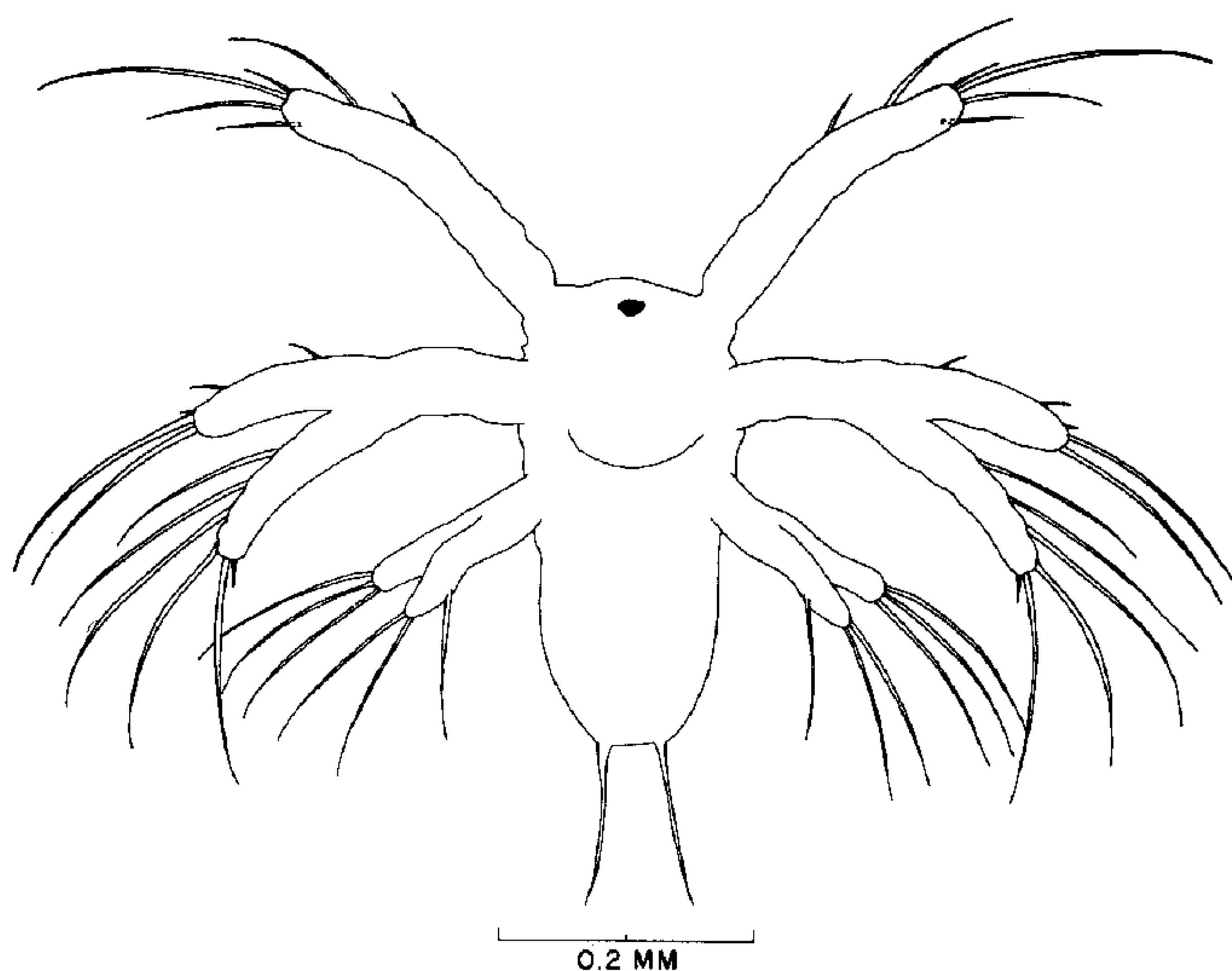


FIGURE 3.—Nauplius II, ventral view.

**Second antenna:**

Endopod: Two short ventrolateral; one small spike and two long terminal.

Exopod: Three long ventrolateral; two long and one short terminal.

Mandible: Same as Nauplius I.

**NAUPLIUS III**

(Fig. 4)

Mean TL = 0.40 mm (0.36-0.43 mm)

Mean W = 0.21 mm (0.20-0.23 mm)

N = 51

The posterior portion of the body is more elongate than in previous substages, but the shape remains essentially the same. The body is slightly depressed between the two developing furcal processes, each of which bears four spines. The small dorsomedian spine, absent in the second nauplius, reappears. The beginnings of ventral appendages can be seen as small indentations posterior to the labrum. The bases of the mandibles have become slightly swollen, and small frontal organs are present at the anterior end of the body.

**Setation of appendages:**

First antenna: One short and two medium ventrolateral; one short, one medium, and one

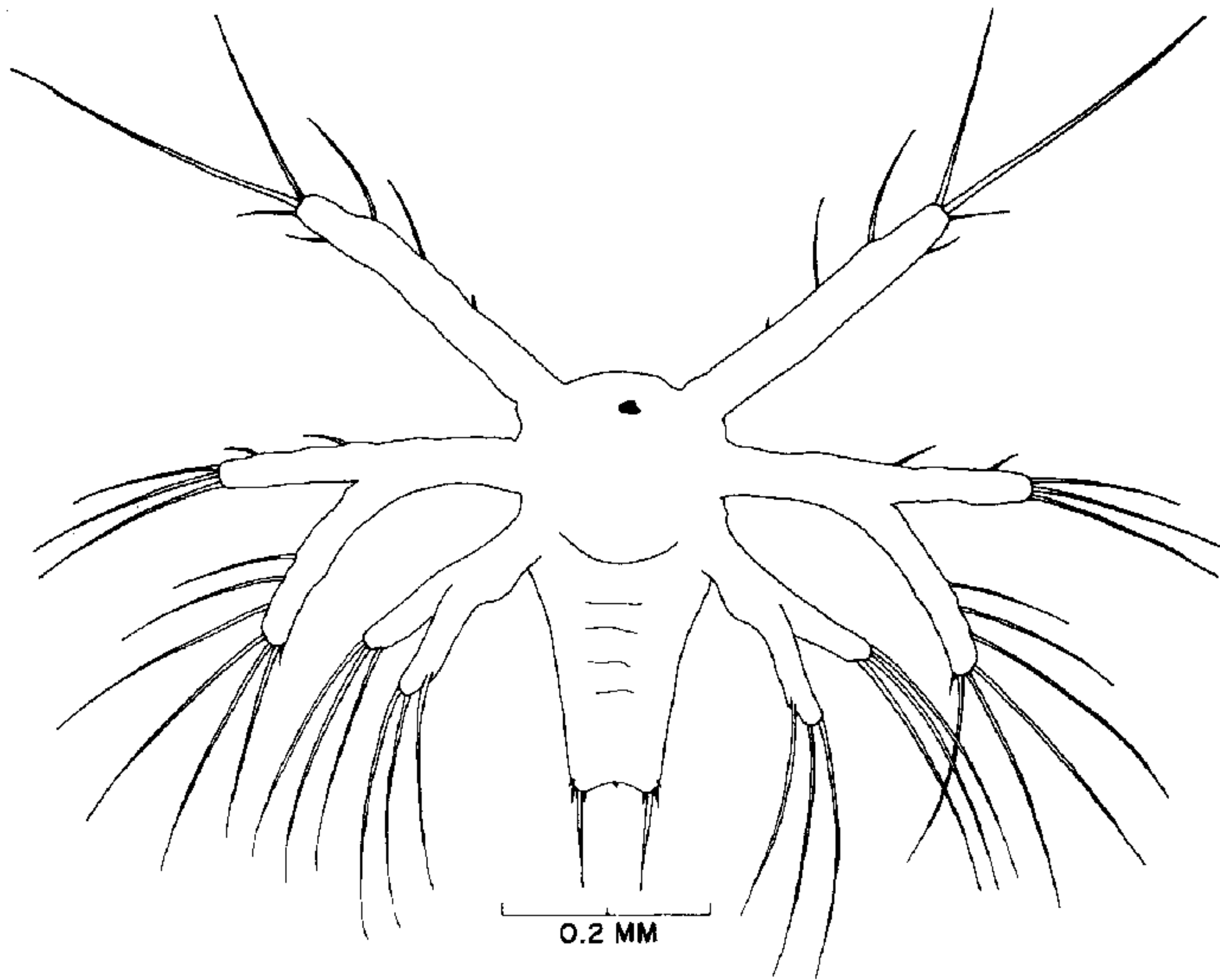


FIGURE 4.—Nauplius III, ventral view.

long terminal; one short dorsolateral.

Second antenna:

Endopod: Two short ventrolateral; three long terminal.

Exopod: Three long ventrolateral; three long and one short terminal.

Mandible: Same as Nauplius I.

#### NAUPLIUS IV

(Fig. 5)

Mean TL = 0.44 mm (0.41-0.47 mm)

Mean W = 0.21 mm (0.20-0.22 mm)

N = 35

The posterior portion of the body has become more slender and two definite rounded furcal processes are formed, each one with six spines. The small dorsomedian spine on the body is absent and does not reappear in later substages. Ventral appendages (first and second maxillae and first and second maxillipeds), still covered by the cuticle, are visible posterior to the mandibles. Frontal organs are present.

Setation of appendages:

First antenna: Same as Nauplius III.

Second antenna:

Endopod: Two short ventrolateral; one short and three long terminal.

Exopod: Four long ventrolateral; two long, one medium, and one short terminal.

Mandible: Same as Nauplius I.

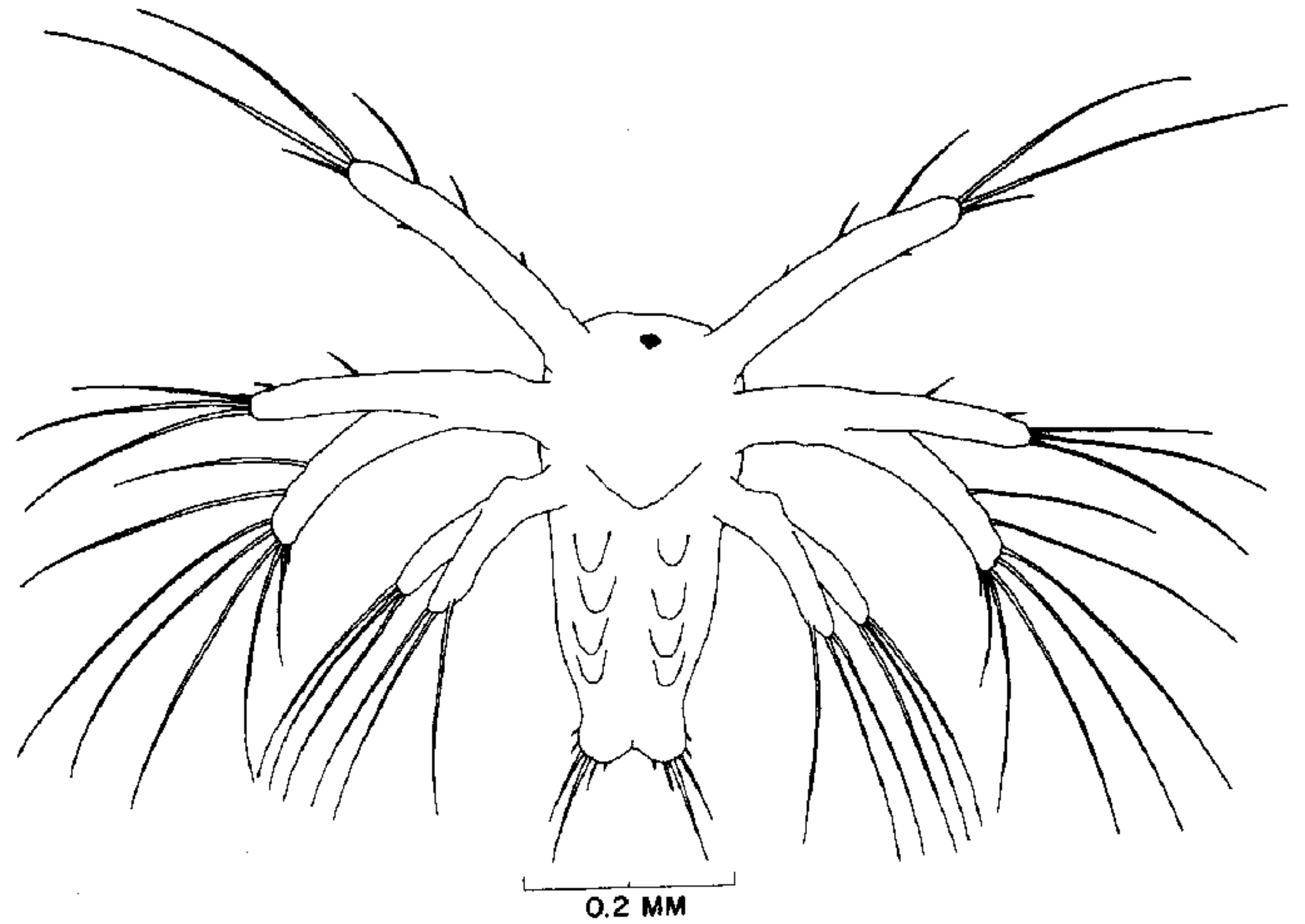


FIGURE 5.—Nauplius IV, ventral view.

#### NAUPLIUS V

(Fig. 6)

Mean TL = 0.50 mm (0.43-0.58 mm)

Mean W = 0.20 mm (0.18-0.22 mm)

N = 41

The body is further elongated and the furcal processes are more pronounced, each giving rise to seven spines. The maxillae and maxillipeds are now external and show more advanced development. The swelling at the base of the mandible is large and prominent and has a masticatory surface composed of several rows of small teeth. The endopod and the exopod of the mandible are frequently hollow and transparent. The outline of a developing carapace can be seen on the dorsal surface of the body, and frontal organs are present.

In living specimens, eyes and an anal canal are visible internally. In preserved specimens, the anal canal appears to open externally.

It was not possible to determine if the appendages were truly segmented. The appendages of some specimens appeared segmented, i.e., their surfaces possessed annular indentations; those of others did not.

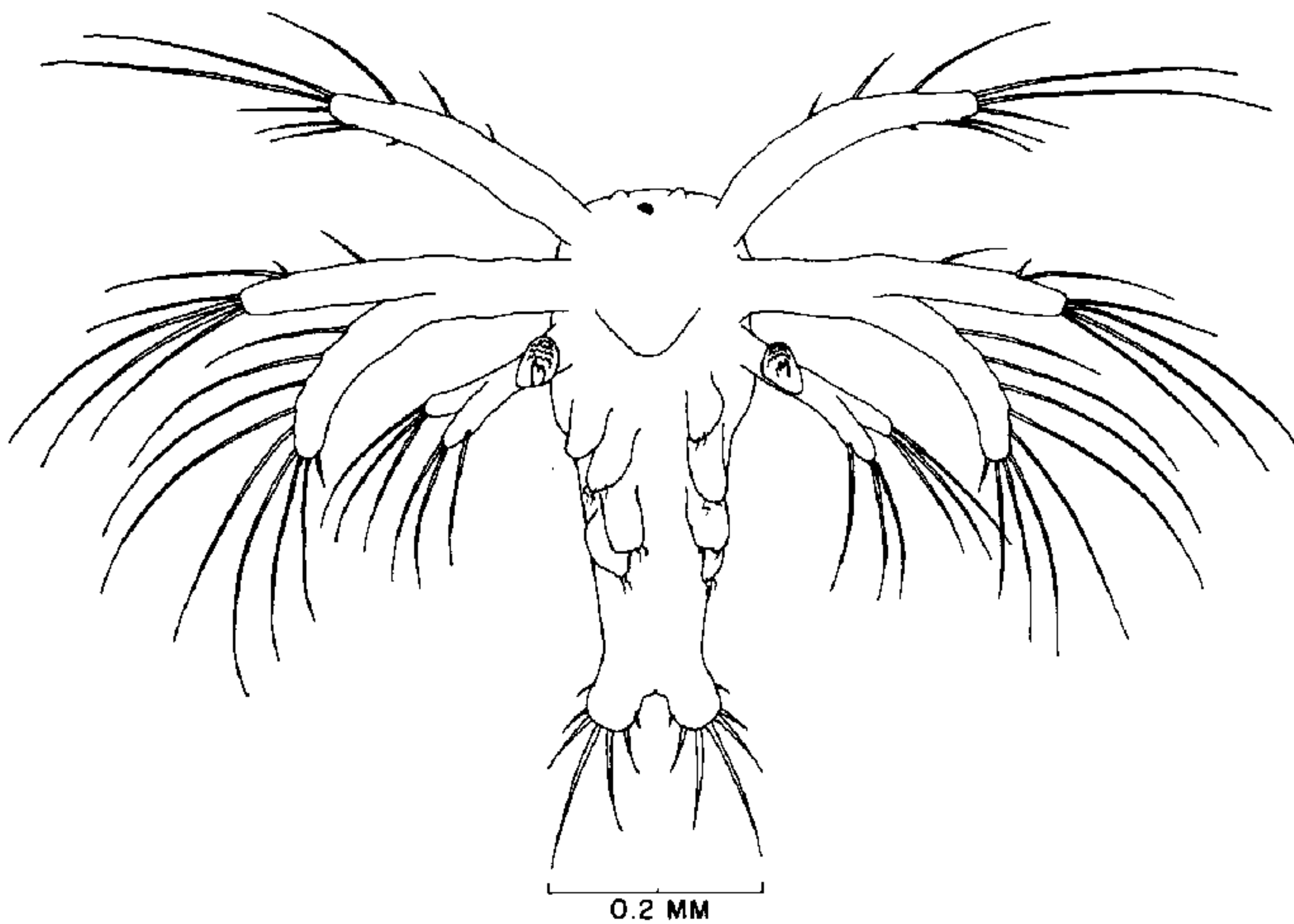


FIGURE 6.—Nauplius V, ventral view.

## Setation of appendages:

**First antenna:** Two short and one medium ventrolateral; two long and one medium terminal; two medium and one short dorsolateral.

**Second antenna:**

**Endopod:** Two short and one medium ventrolateral; one medium and three long terminal.

**Exopod:** Five long ventrolateral; three long and one short terminal.

**Mandible:** Same as Nauplius I.

**PROTOZOEIA I**

(Fig. 7)

Mean TL = 0.96 mm (0.89-1.21 mm)

Mean CL = 0.45 mm (0.40-0.49 mm)

N = 40

With the molt from Nauplius V to Protozoa I, the larvae change radically. A large, loose-fitting carapace covers the anterior portion of the body. The narrow posterior portion is divided into a six-segmented thorax and an unsegmented abdomen. The masticatory surface of the mandible has become greatly enlarged, and the endopod and exopod have been lost. The maxillae and maxillipeds are large and functional.

The carapace is rounded with a median notch at the anterior end; two rounded frontal organs

are the only protuberances on it. An ocellus, which persists in subsequent protozoal sub-stages, is present between a pair of compound eyes covered by the carapace. The labrum is smaller than in the preceding stage and has a short spine on its anterior margin. Two lobes of the labium, with short bristles on their inner margins, are posterior to the labrum. The mandibles curve inward and several of their teeth can be seen between the labrum and labium.

The first antenna, which is about equal in length to the endopod plus the protopod of the second antenna, is composed of three major segments. The basal segment is divided into five subsegments and bears one short seta. The second segment possesses three setae, two ventrolateral, and one posterolateral. The distal segment has three terminal and three subterminal setae.

The second antenna consists of a protopod of three segments, an endopod of two segments, and an exopod of 10 segments. The endopod bears one seta at the juncture with the protopod, another on the first segment, two at the juncture of the first and second segments, and five terminal setae on the distal segment. The exopod has eight setae on its ventrolateral and two on its dorsolateral margins, as well as three terminal setae.

The mandible has lost its exopod and endopod. The masticatory surface now faces medially and has several rings of teeth.

The first maxilla is composed of an unsegmented protopod, an endopod of three segments, and a small knoblike exopod. The protopod consists of two large lobes, each bearing several stout, toothed spines. The first segment of the endopod possesses two or three setae; the second, two; and the distal, five. The exopod bears four setae.

The second maxilla is about the same size as the first. It has an unsegmented protopod, an endopod of four segments, and a knoblike exopod. The protopod has five lobes on its ventral margin; the basal lobe bears approximately eight setae, the remainder three to six. The first three segments of the endopod each

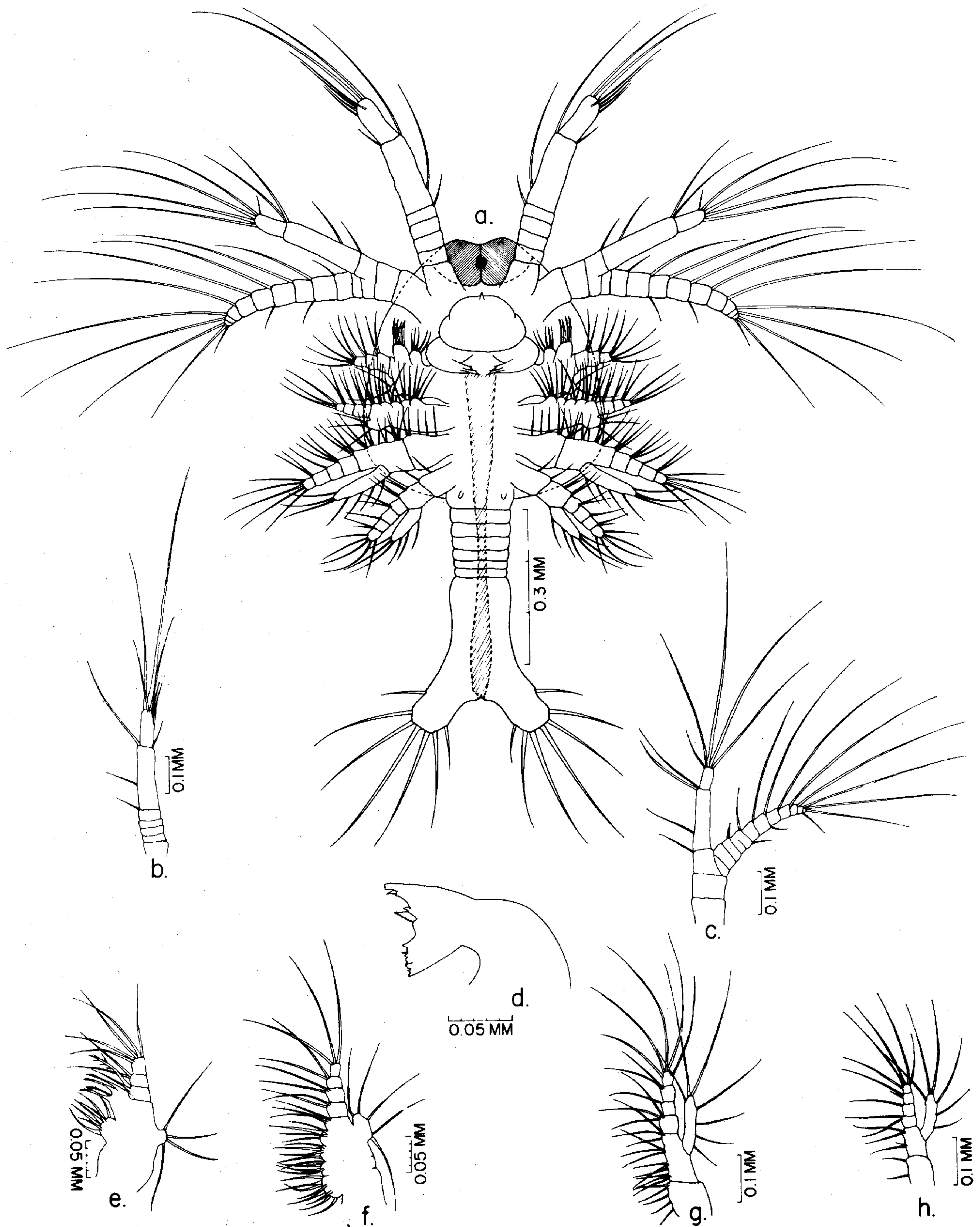


FIGURE 7.—Protozoa I: a, ventral view; b, antenna I; c, antenna II; d, mandible; e, maxilla I; f, maxilla II; g, maxilliped I; h, maxilliped II.

have two setae, and the fourth, three. The exopod has five setae.

The first maxilliped is biramous and longer than the maxillae. It has a protopod of two segments, an endopod of four segments, and an unsegmented exopod. The protopod bears about 17 setae. The basal segment of the endopod possesses three setae; the second, one or two; the third, two; and the terminal, five. The exopod has four lateral and three terminal setae.

The second maxilliped, though smaller, is almost identical to the first. The protopod bears six setae. The endopod is composed of four segments, the first and third giving rise to two setae; the second, one or two; the fourth, five. The exopod has three lateral and three terminal setae.

The third maxilliped is present only as a small bud.

The caudal furcae each retain seven spines and are separated by a well-defined anal opening. The digestive tract is visible posterior to the labrum.

The body is colorless and almost transparent with the exception of two red spots, one on each side of the anal opening.

## PROTOZOEAL II

(Fig. 8)

Mean TL = 1.71 mm (1.28-2.01 mm)

Mean CL = 0.80 mm (0.72-0.87 mm)

N = 25

The most apparent modification from the preceding substage is the presence of stalked compound eyes. Additional features that characterize this substage are a ventrally projecting rostrum, a pair of bifurcate supraorbital spines, and a segmented abdomen.

Frontal organs are absent in this and later stages.

Segmentation of the appendages remains the same as described for the first protozoa. The only changes in setation are on the first antenna. Several setules are added near the posterolateral seta on the second segment, and an additional terminal seta is found on the last segment. Rudiments of the third maxilliped and five pairs of pereopods are present.

The abdomen is divided into six segments, the telson not being separated from the sixth. The number of furcal spines remains constant at seven pairs.

## PROTOZOEAL III

(Fig. 9)

Mean TL = 2.59 mm (2.40-2.59 mm)

Mean CL = 1.06 mm (0.93-1.40 mm)

N = 15

The principal differences between this substage and the preceding one are the presence of biramous uropods and spines on the abdominal segments.

The carapace is close fitting and covers all but the last three thoracic somites. The supra-orbital spines are no longer bifurcate.

The five subsegments comprising the basal section of the first antenna in the preceding protozoal substages have fused into a single unit. The ventrolateral seta that originated from the middle of the second segment has been lost, and a similar one is present on the distal margin. The second antenna, mandible, and maxillae remain essentially the same as in the preceding substage. Two setae have been added to the exopod of the first maxilliped. The first segment of the endopod and the exopod of the second maxilliped have gained a seta. Although the third maxilliped and five pereopods have developed further and are now biramous, they remain functionless.

The abdomen is divided into six segments, the telson being distinct from the sixth segment. The sixth segment is about three-fourths the length of the preceding five combined. Each of the first five segments has a dorsomedian spine on its posterior margin. The fifth segment also possesses a pair of midlateral spines, and the sixth somite has paired midlateral and ventrolateral spines.

A pair of biramous uropods are present, originating from the ventroanterior margin of the telson. The exopod, slightly longer than the endopod, bears five or six setae at its apex.

An additional pair of caudal spines have been added medially on the telson, making a total of eight pairs.

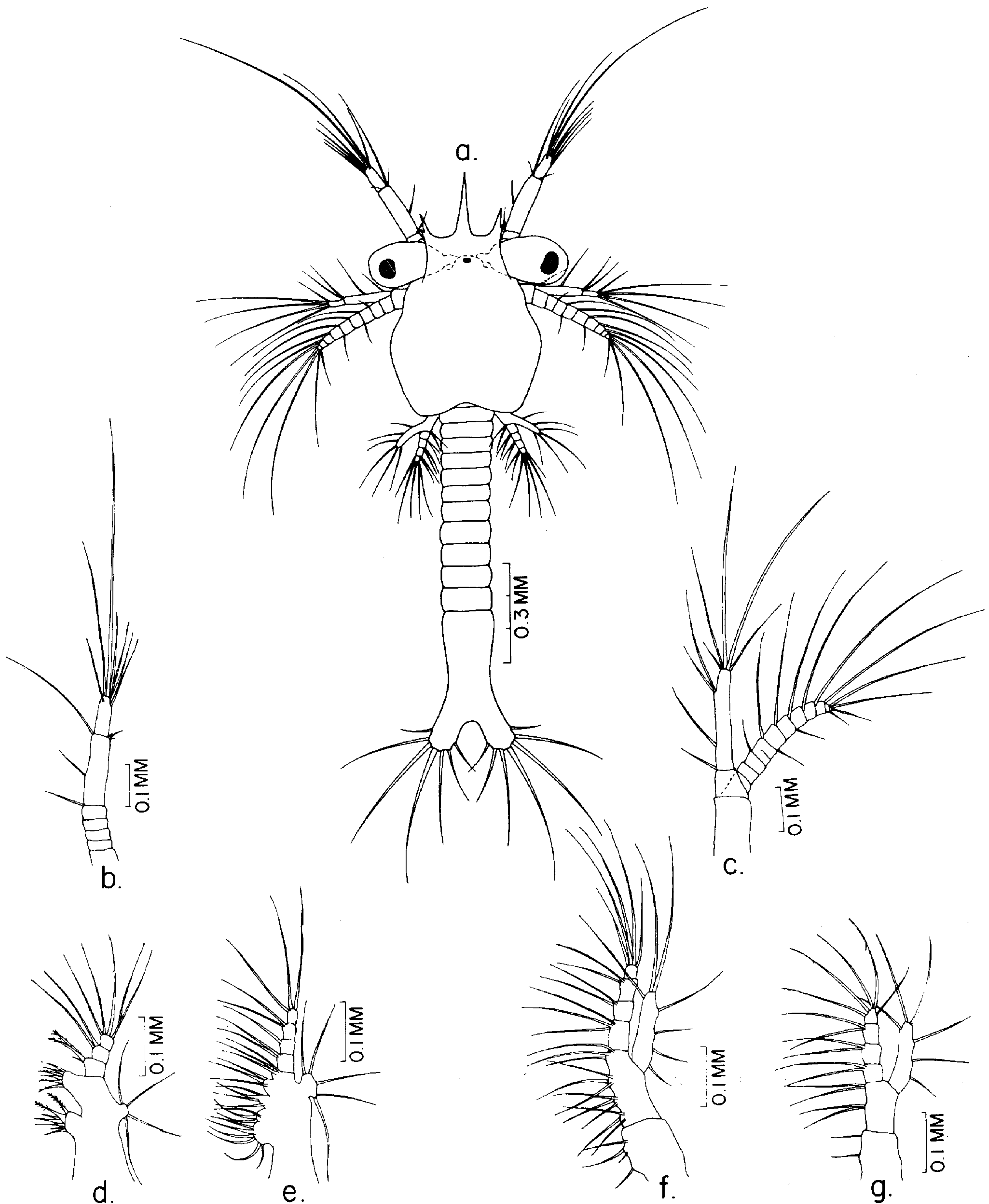


FIGURE 8.—Protozoa II: a, dorsal view; b, antenna I; c, antenna II; d, maxilla I; e, maxilla II; f, maxilliped I; g, maxilliped II.

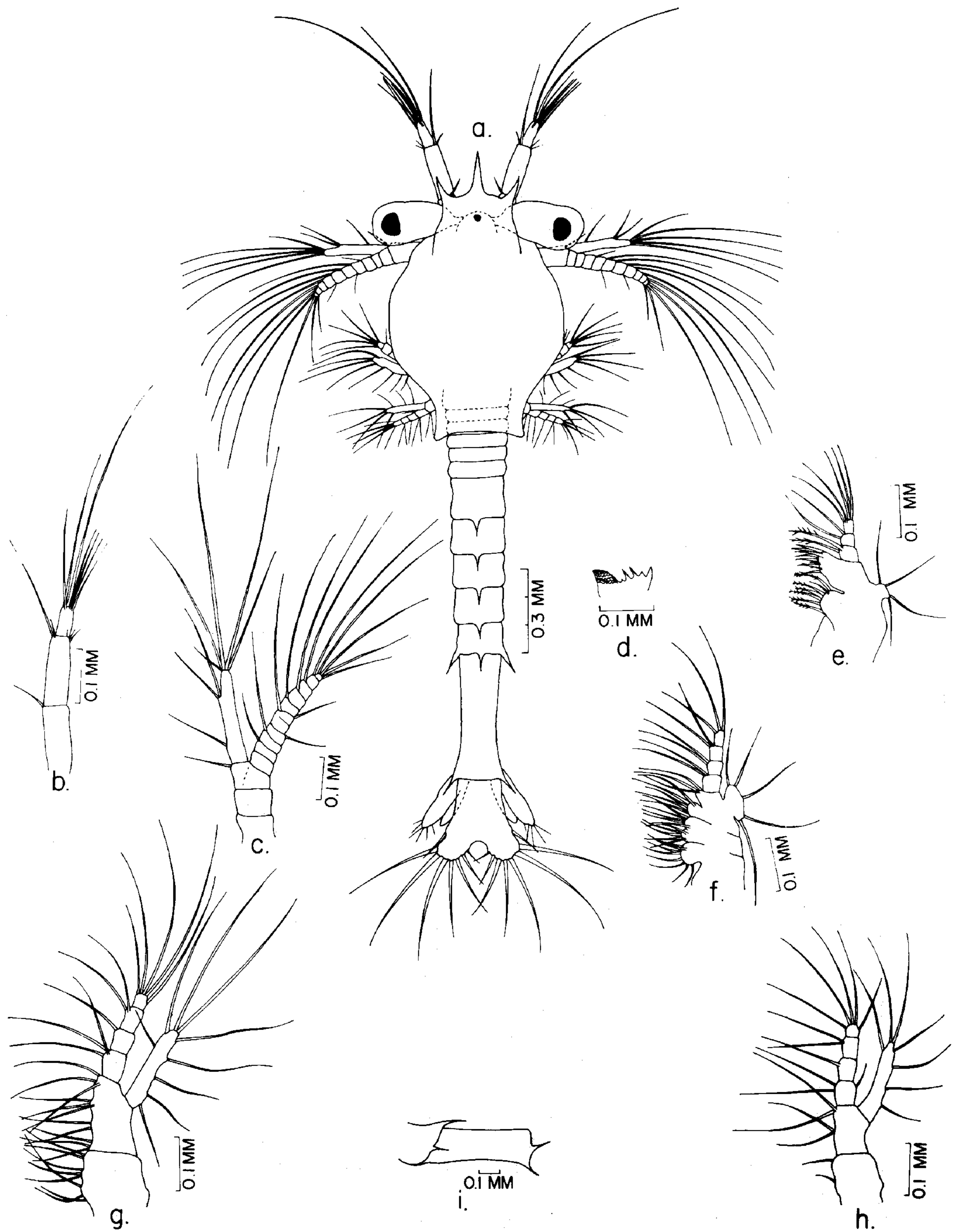


FIGURE 9.—Protozoaea III: a, dorsal view; b, antenna I; c, antenna II; d, teeth of mandible; e, maxilla I; f, maxilla II; g, maxilliped I; h, maxilliped II; i, abdominal segments V and VI.

**MYSIS I**

(Fig. 10)

Mean TL = 3.3 mm (3.2-3.5 mm)

Mean CL = 1.2 mm (1.1-1.3 mm)

N = 18

With the molt from the third protozoal to the first mysis substage, the larvae undergo another radical change and assume a more shrimplike appearance. The most apparent change is the development of functional pereopods with long brushlike exopods. The antennae also undergo considerable change, with the exopods of the second antennae becoming modified to form flattened antennal blades.

The carapace fits the body more closely than in preceding stages and covers all but the last two thoracic somites. The rostrum is not depressed as in the protozoal substages, but protrudes forward on a horizontal plane. Supra-orbital spines are still present although reduced in size. A small spine now occurs on the antero-ventral corners of the carapace. In addition, a pair of hepatic spines have been added to the carapace, one spine on each side originating from a point located approximately one-sixth the carapace length from the anterior margin.

An ocellus is present in this and subsequent mysis substages.

The first antenna is composed of three segments, the first being  $1\frac{1}{2}$  times the length of the second and third combined. Numerous setae now occur along the appendage, and several arise at the apex of each segment. In addition, a prominent ventromedian spine is present on the first segment. The distal segment gives rise to two unsegmented branches, the external one bearing six or seven setae and being twice as long as the internal one, which bears two terminal setae.

The second antenna consists of a protopod of two segments, an unsegmented endopod with three lateral and three terminal setae, and a flattened, unsegmented, bladelike exopod with a single lateral seta and 11 setae along the medial and terminal margins.

The mandible and maxillae remain essentially the same as in the preceding substage except

that the exopod of the second maxillae has become enlarged and bears 10 setae. The first and second segments of the endopod of the first and second maxillipeds have acquired an additional seta. The exopod of the first maxilliped has gained a seta and that of the second has lost three. The third maxilliped has evolved further and is now longer than the first two. It has a two-segmented protopod that bears two setae. The first segment of the five making up the endopod possesses two setae; the second, one; the third, none; the fourth, three; and the fifth, five. The unsegmented exopod has five or six terminal and subterminal setae.

The five pairs of pereopods have undergone considerable enlargement and their exopods serve as the principal swimming organs during the mysis stage. The endopods of the first three pairs are modified into rudimentary chelae that have four or five terminal setae. The first pereopod consists of a protopod of two segments, an unsegmented endopod, and an exopod which bears five or six terminal and subterminal setae. The last four pereopods were not examined in detail.

The dorsomedian spines of the first two abdominal segments have been lost while those on the third, fourth, and fifth segments are still prominent. The fifth segment retains a pair of midlateral spines. A dorsomedian and a ventromedian spine are present on the sixth segment in addition to the paired midlateral and ventrolateral spines found in the preceding substage. Anlages of the pleopods can be seen on the ventral surface of the first five abdominal segments.

The uropod has developed an unsegmented protopod that possesses a large posteroventral spine and a smaller posterolateral spine. The endopod carries 11 setae on its medial and terminal borders, while the exopod, which has about 13 setae on its medial and terminal margins, has, in addition, a prominent spine on its posterolateral edge.

The telson is cleft terminally and bears seven pairs of terminal and one pair of lateral spines.

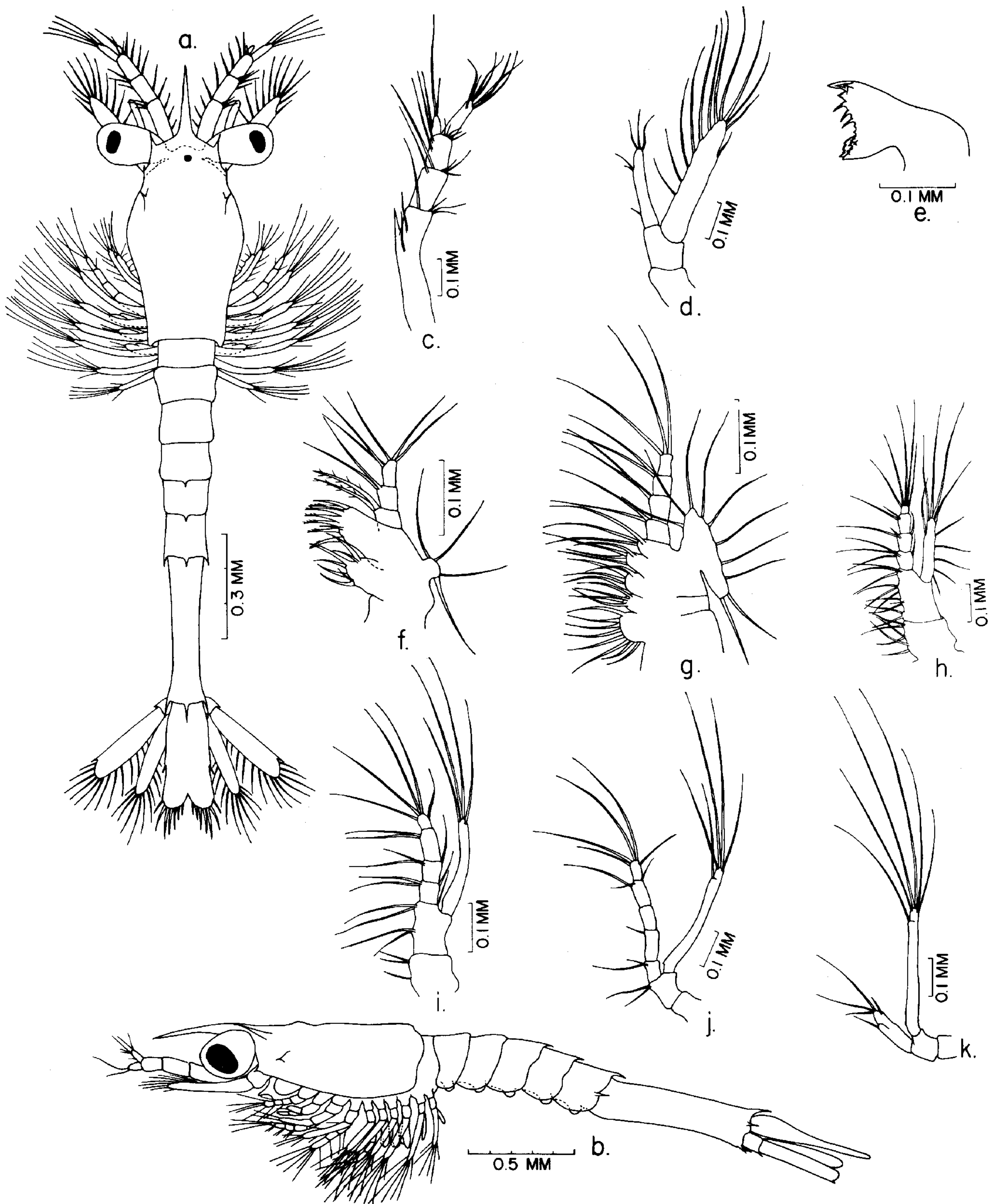


FIGURE 10.—Mysis I: a, dorsal view; b, lateral view; c, antenna I; d, antenna II; e, mandible; f, maxilla I; g, maxilla II; h, maxilliped I; i, maxilliped II; j, maxilliped III; k, pereopod I.

**MYSIS II**

(Fig. 11)

Mean TL = 3.8 mm (3.3-4.2 mm)

Mean CL = 1.3 mm (1.2-1.4 mm)

N = 11

This substage can be distinguished from the first mysis by the presence of unsegmented pleopods and a spine on the antennal blade.

The addition of a dorsal spine on the rostrum is the only change in armature of the carapace which now covers the entire thorax.

The terminal branches of the first antenna are almost equal in length. A developing statocyst appears as a slight bulge near the base of the appendage.

Setation on the endopod of the second antenna has been reduced to a single terminal seta. The number of setae on the exopod has increased to 18, and they occur along the medial border and around the tip to the point of insertion of a subterminal spine on the lateral margin. A spine has been added to the terminus of the protopod.

The mandible has developed a small unsegmented palp.

The exopod of the first maxilla is no longer present; that of the second maxilla has increased in size and now bears 13 setae. A seta now arises from the protopod of the first maxilliped at a point between the insertion of the endopod and exopod. In addition to a seta on the distal segment, the endopod of the second maxilliped gains a fifth segment that does not possess setae. The protopods of the third maxilliped and first pereopod have gained a seta. A single seta on the basal segment is the only one present on the three segments that have been added to the endopod of the first pereopod. Rudiments of gills are present as small protuberances on the bases of the protopods of the maxillipeds and first pereopods.

The armature of the abdomen and uropods is unchanged from the preceding substage. Rudimentary, unjointed pleopods are present on the ventral surface of the first five abdominal segments.

The telson has six pairs of terminal and two pairs of lateral spines.

**MYSIS III**

(Fig. 12)

Mean TL = 4.3 mm (3.9-4.7 mm)

Mean CL = 1.4 mm (1.3-1.5 mm)

N = 21

In this substage, the pleopods and endopod of the second antenna are composed of two segments. These characters serve to differentiate third mysis from preceding substages.

Spination of the carapace remains essentially the same as in Mysis II, although a second dorsal spine on the rostrum was found in approximately one-half of the preserved specimens.

The outer branch arising from the distal segment of the first antenna is longer than the inner branch and is composed of two segments. A lateral seta has been added to the endopod of the second antenna which is now also composed of two segments; the exopod likewise possesses one more seta.

The mandibular palp is slightly longer and has a weak apical seta.

The first maxilla and first maxilliped remain unchanged. The exopod of the second maxilla has become elongate and has 18 setae, while those of the second and third maxillipeds and first pereopod have two segments. The fourth segment of the endopod of the second maxilliped has gained one seta, as has the exopod. One seta has been added to the second segment of the endopod of the third maxilliped and two to the third; the fourth has lost one. The endopod of the first pereopod is composed of five segments, with the fourth forming the propodus of the chela and the fifth the dactylus; the second segment has gained one seta, and the third, two. The gills on the maxillipeds and first pereopod have enlarged.

The only change of consequence in the posterior portion of the body involves the pleopods, which are now composed of two segments and bear two or three terminal setae.

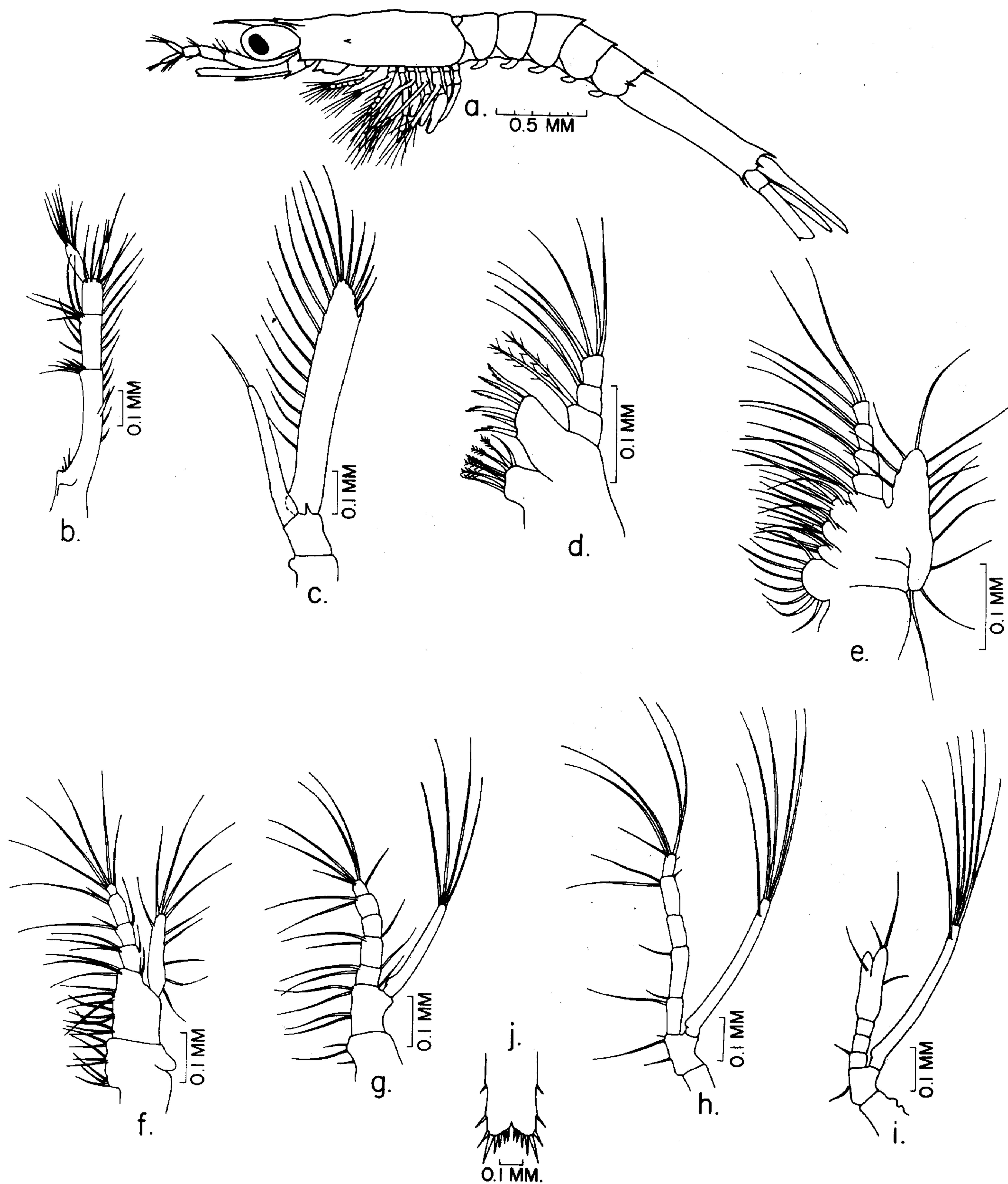


FIGURE 11.—Mysis II: a, lateral view; b, antenna I; c, antenna II; d, maxilla I; e, maxilla II; f, maxilliped I; g, maxilliped II; h, maxilliped III; i, pereopod I; j. tip of telson.

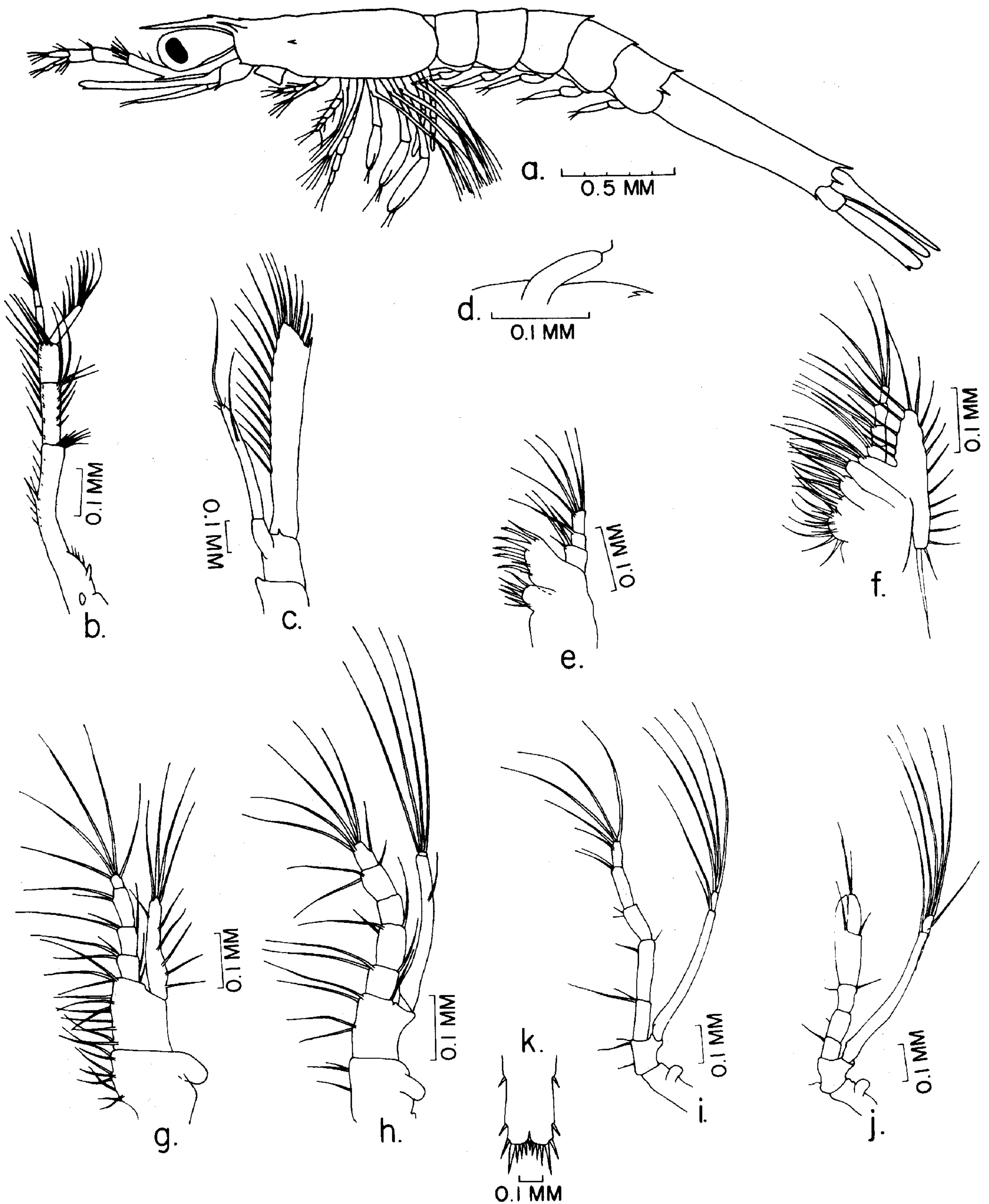


FIGURE 12.—Mysis III: a, lateral view; b, antenna I; c, antenna II; d, mandibular palp; e, maxilla I; f, maxilla II; g, maxilliped I; h, maxilliped II; i, maxilliped III; j, pereopod I; k, tip of telson.

## POSTLARVA I

(Fig. 13)

Mean TL = 4.6 mm (4.2-5.0 mm)

Mean CL = 1.5 mm (1.4-1.6 mm)

N = 15

No drastic changes in morphology are associated with the molt from the third mysis to the first postlarval stage. The pleopods, now well developed and setose, are the principal swimming organs. There is usually a reduction in the size of the exopods of the pereopods, which, if present, are only vestigial.

The carapace is much the same as in the third mysis. The rostrum bears one or two spines and extends slightly beyond the distal border of the eye. The small spine present on the antero-ventral corners of the carapace in the preceding substage is absent. The supraorbital spines are now minute or absent. A pair of hepatic spines and ocelli are present.

The inner branch of the first antenna is composed of two segments, and the outer, three. The statocyst at the base of the first antenna is fully developed. The endopod of the second antenna is composed of five or six frequently indistinct segments. The exopod bears 23 setae.

The mandibular palp is two-segmented and possesses five setae.

The endopods of the first and second maxillae have been reduced greatly and are now unsegmented and usually without setae. Setation of the protopod of the second maxilla has been reduced while its exopod has become enlarged and now bears 21 setae.

The first maxilliped retains only rudiments of its endopod and exopod. The second and third maxillipeds and the first pereopod have lost all but a vestige of their exopods. The endopod of the second maxilliped has become recurved, and its setation has changed greatly: the first segment has three setae; the second, four; the third, one; the fourth, five; and the fifth, six. The second and third segments of the endopod of the third maxilliped have each gained one seta, the fourth, three; the number of setae on the terminal segment varies from three to six. The dactyl of the first pereopod now possesses several small teeth and short bristles terminally.

Each pleopod is composed of two segments, the distal one bearing about 10 setae.

The presence of dorsomedian spines on the third, fourth, and fifth abdominal segments is variable. Such spines may be absent or present on one or more of the segments. The midlateral spines have been lost from the fifth and sixth segments. The sixth segment retains a dorsomedian and paired ventrolateral spines.

The telson, which is now only faintly cleft, bears five pairs of terminal and three pairs of lateral spines.

COMPARISON WITH  
PINK AND WHITE SHRIMP

During the fall of 1964, pink shrimp hatched from eggs spawned in the laboratory were reared to postlarvae. White shrimp were reared during the summer of 1966. Examination of these larvae showed them to be identical to brown shrimp larvae in setation and other major morphological characteristics. Various parts of the body were measured to determine if body proportions differed between the species; the results proved inconclusive.

Dobkin (1961) described the larval development of the pink shrimp but was absolutely certain only of the identity of the naupliar and first protozoal substages which he obtained from eggs hatched in the laboratory. Descriptions of the more advanced stages were based on specimens sorted from plankton samples. When the pink shrimp we had reared were compared with the specimens described by Dobkin, several differences were noted. These are listed in Table 1.

Pearson (1939) and Heegaard (1953) described the larval development of the white shrimp from material taken in plankton tows. Comparison of these descriptions and our specimens was not attempted because we feel both Pearson's and Heegaard's descriptions of the later stages are not detailed enough for itemized comparison. In addition, Heegaard's editors felt that his figures of the first and second protozoae were not referable to *P. setiferus*, but should be attributed to *Trachypenaeus*, *Sicyonia*, or *Xiphopenaeus*. From material at our disposal it

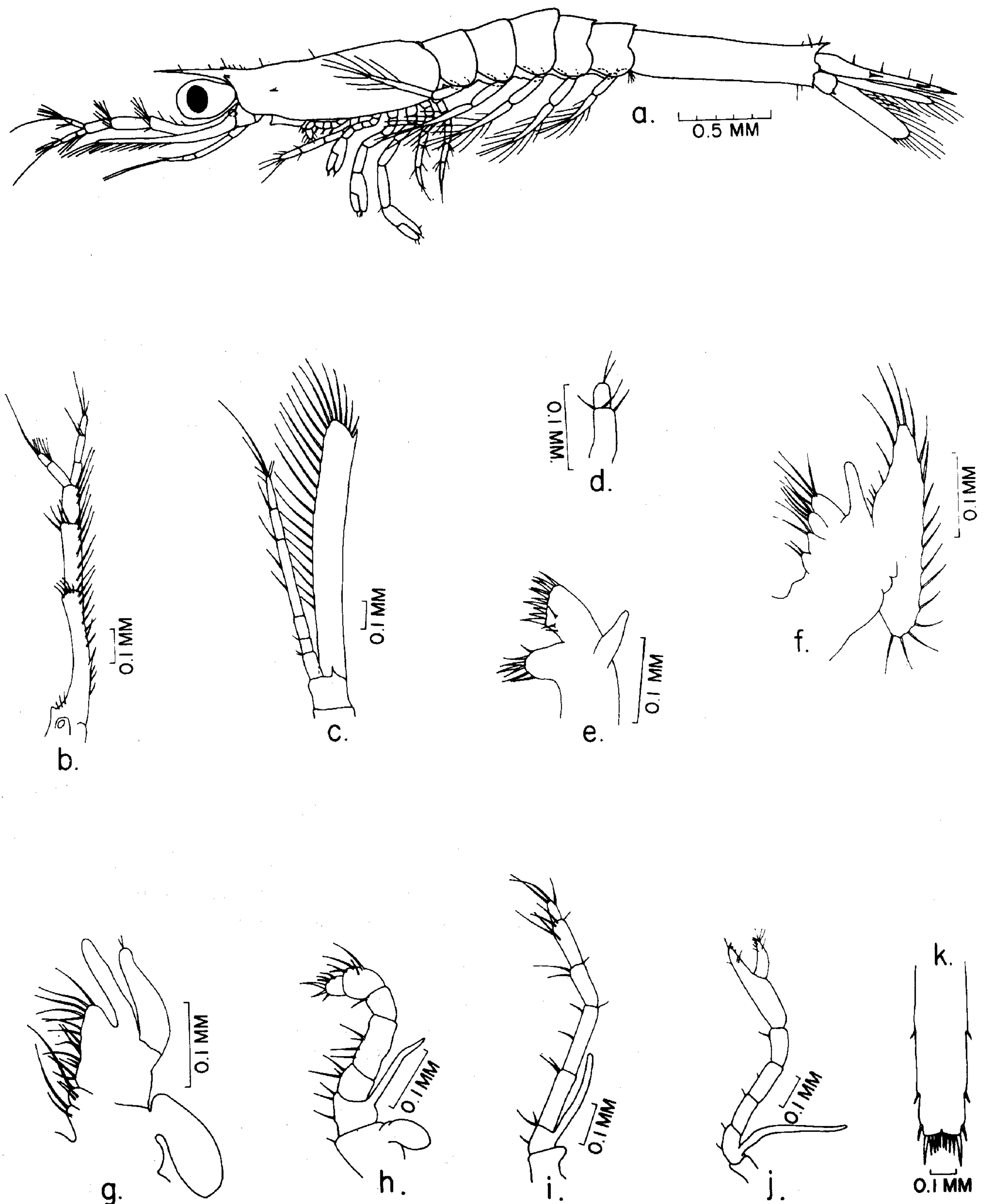


FIGURE 13.—Postlarva I: a, lateral view; b, antenna I; c, antenna II; d, mandibular palp; e, maxilla I; f, maxilla II; g, maxilliped I; h, maxilliped II; i, maxilliped III; j, pereopod I; k, tip of telson.

TABLE 1.—Comparison between published description of *P. duorarum* and specimens examined by authors

Substage and body part	Dobkin (1961)	Cook and Murphy
Nauplius III		
Antenna I	No mention of postero-lateral seta.	A minute posterolateral spine may be present.
Caudal spines	Three pairs.	Three or four pairs.
Nauplius IV		
Antenna I	Two anterolateral and no posterolateral spines.	Two or three anterolateral spines. Minute posterolateral spine may be present.
Caudal spines	Five pairs.	Six pairs.
Nauplius V		
Antenna I	Two posterolateral setae.	Two or three posterolateral spines.
Protozoa I		
Antenna I	Five terminal and sub-terminal setae. No posterolateral seta on middle segment.	Six terminal and sub-terminal setae. Middle segment with short posterolateral seta.
Protozoa II and III		
Antenna I	Five terminal and sub-terminal setae.	Seven terminal and sub-terminal setae.
Mysis		
Sixth abdominal segment	Two pairs of posterolateral spines.	One pair of posterolateral spines.
Protopod of uropod	Three spines on distal margin.	Two spines on distal margin.

would seem that the editors were correct and that the figures presented are species of *Trachypenaeus*.

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